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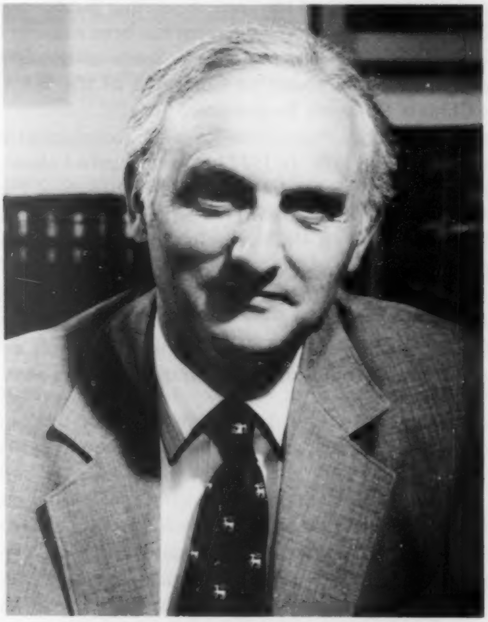

Photograph by courtesy of Rutherford Appleton Laboratory

Director-General of the Meteorological Office

Dr J. T. Houghton, CBE, FRS, has been appointed to succeed Sir John Mason as Director-General of the Meteorological Office from 1 October 1983; he has been Deputy Director of the Rutherford Appleton Laboratory at Chilton since 1979, and Professor of Atmospheric Physics in the University of Oxford since 1976.

Dr Houghton was educated at Rhyl Grammar School and Jesus College, Oxford, where he graduated in Physics in 1951. After three years post-graduate work he became a Research Fellow at RAE Farnborough in 1954 but returned to Oxford in 1958 as Lecturer in Atmospheric Physics, being appointed Reader in 1962. While at Oxford he achieved a high international reputation for his investigations of the structure and composition of the stratosphere and mesosphere; in particular he has invented, designed, and operated ingenious radiometers and spectrometers to measure temperatures and the concentrations of trace chemicals in the high atmosphere from satellites. He has built up a strong research group at the University which, in collaboration with the Rutherford Appleton Laboratory, has been outstandingly successful in applying modern space technology to build a series of very advanced instruments to be flown on American meteorological satellites; the group is currently engaged in the design of new instruments to be flown both on American satellites and on the European Earth Resources Satellite (ERS1) due to be launched in 1988. His appointment will strengthen the ties between Oxford University and the Office in the field of satellite meteorology.

Internationally, Dr Houghton's expertise and judgement has been much in demand by the European Space Agency and the US National Aeronautics and Space Administration, and also in the meteorological world through his appointment as Chairman of the WMO/ICSU Joint Scientific Committee for the World Climate Research Programme.

Dr Houghton was awarded the Buchan Prize of the Royal Meteorological Society in 1966 and served as President of the Society from 1976 to 1978. In 1972 he was elected a Fellow of the Royal Society, and in 1979 was awarded the Charles Chree Medal and Prize of the Institute of Physics. He is the author of numerous scientific papers, a well-known textbook, *The physics of atmospheres,* and has collaborated with Professor S. D. Smith of Heriot-Watt University in writing another, *Infra-red physics.*

Dr Houghton is already well known to many of the staff of the Meteorological Office, and his membership of the Meteorological Committee, together with his experience as Chairman of the now discontinued Meteorological Research Committee, will have made him familiar with many of the problems facing the Office at the present time. He brings with him a distinguished record of achievement in scientific research and technical administration, and we wish him every success in his new post.

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A study of the Gumbel and Weibull methods of extreme-value analysis using air temperature data from six Ocean Weather Stations

By Anne E. Graham

(Meteorological Office, Bracknell)

Summary

Extreme air temperatures for six locations at sea were estimated using both the Gumbel and Weibull methods of extreme-value analysis. No systematic relationships were found between the extremes derived using the Gumbel method and those derived using the Weibull method.

It is shown that reduction in the interdependence of the data used in the Weibull method has little effect upon the differences between extremes estimated using the two methods.

1. Introduction

The estimation of extreme values is important for design and planning purposes to ensure that a structure is able to withstand the likely extreme conditions which it could experience during its expected lifetime. For this purpose an extreme value is quoted as the value likely to be exceeded, on average, once in some number of years (often 50 or 100). The use of the expression 'on average' is very important though often misunderstood. The extreme is merely that value which is estimated to have a probability of occurrence equivalent to its being exceeded once in a given period. In reality it could be exceeded once, several times, or not at all during any period of that length. The period is known as the 'return period'.

In order to estimate extreme values it is necessary to fit a convenient distribution to the data and extrapolate the function to the desired return period. This technique depends upon the ability of the chosen function to describe the population of values with particular reference to the extremes located in the 'tail' of the distribution.

The two distributions most frequently used by the Climatological Services Branch of the Meteorological Office are the Gumbel (Gumbel 1958) and Weibull (Weibull 1951) distributions. The Gumbel (or Fisher–Tippett Type I) extreme-value distribution is usually fitted to annual maxima (or minima). The extreme-value analysis of annual maxima has been discussed by Tabony (1983), with particular reference to the need for sufficiently long periods of data.

To identify annual maxima, regular observations are required for a specific location. The only sources of regular observations over long periods at sea come from the Ocean Weather Stations (OWS) but there are few of these and extremes are often required in other areas where regular observations are not available. Data from ships of the Voluntary Observing Fleet (VOF) are available for most of the world's oceans. The VOF consists of ordinary merchant ships whose deck officers voluntarily make observations of meteorological and sea conditions during voyages so that these data are randomly distributed in space and time and maxima cannot be identified.

The method of extreme-value analysis used for the VOF data is that using the Weibull distribution (Appendix) in which the complete spectrum of all the observed data is fitted so that a complete set of regular observations is not necessary. The extremes are estimated according to the number of observations likely in the given return period.

The derivation of extremes using methods based on annual maxima (when available) are to be preferred since the data are likely to be more independent than in any other form. Also, Tabony (1983) has shown how the lower annual maxima, probably more typical of the main body of data than the rarer events, can affect the extrapolation of the extreme-value distribution; this problem is presumably accentuated in the case of extrapolation using the Weibull method.

Extremes estimated for short return periods by the Weibull method are generally higher than those estimated using Gumbel, and lower for longer return periods. The purpose of this project was to investigate the difference in the extreme values estimated by using each technique and, in particular, it was hoped to be able to identify any systematic differences and to 'calibrate' the extremes derived using the Weibull technique with those derived using the Gumbel technique.

The highly correlated nature of the data used in the Weibull analysis is a matter of some concern and a secondary aim was to investigate the effects of a reduction in the degree of correlation. This correlation is referred to as persistence in the following descriptions since it is often due to the persistence of a particular meteorological situation.

2. Data

In order to compare the extremes estimated by both methods it was necessary to use a data source from which the annual maxima could be extracted. A long period of regular data was used, although this is not the kind of data normally used in the Weibull analysis.

Six OWS were used: 'A', 'C', 'D', 'I', 'J' and 'M', each covering the same 23-year period, 1950–1972, the longest period available where all six OWS could be compared. It was decided to use values of air temperature observed at three-hourly intervals. Successive values of air temperature are highly dependent, therefore, if the Weibull technique should prove sensitive to persistence then any significant reduction in the dependence in the data should be reflected in the extremes produced by the distribution.

Since the comparison of the two methods was to be based on the assumption that Gumbel gave the 'better' result, some idea of the confidence that could be placed in these estimates was needed. This was not attempted quantitatively as in other studies, for example Challenor (1979) which in most cases used the accuracy of fitting the data to the distributions, but qualitatively with reference to the effect of the sample of maxima on the extremes estimated.

(a) *Sensitivity of the Gumbel technique*

The annual maxima for each station are shown in Fig. 1 grouped in 0.5 °C intervals in the form of a histogram. In order to investigate the sensitivity of the Gumbel method to different periods of data, two stations were chosen, OWS 'A' and OWS 'M', and Gumbel analyses were carried out on maxima for three different periods, 14, 23 and 26 years for 'A' and 14, 23 and 31 years for 'M' where 26 and 31 years are the maximum number of years in the data sets. Fig. 2 shows histograms of annual maxima for these periods.

The differences in the distributions of maxima are difficult to quantify but the 14-year period for OWS 'M' appears to be rather different from the 23-year and 31-year periods, while for OWS 'A' there is no such marked difference.

Figs 3 and 4 show the extremes predicted by Gumbel for OWS 'A' and OWS 'M' respectively. The extremes are plotted against log return period for ease of representation.

For OWS 'A' the actual values estimated for each period of data differ, but the relationship between return periods for each set of maxima is similar.

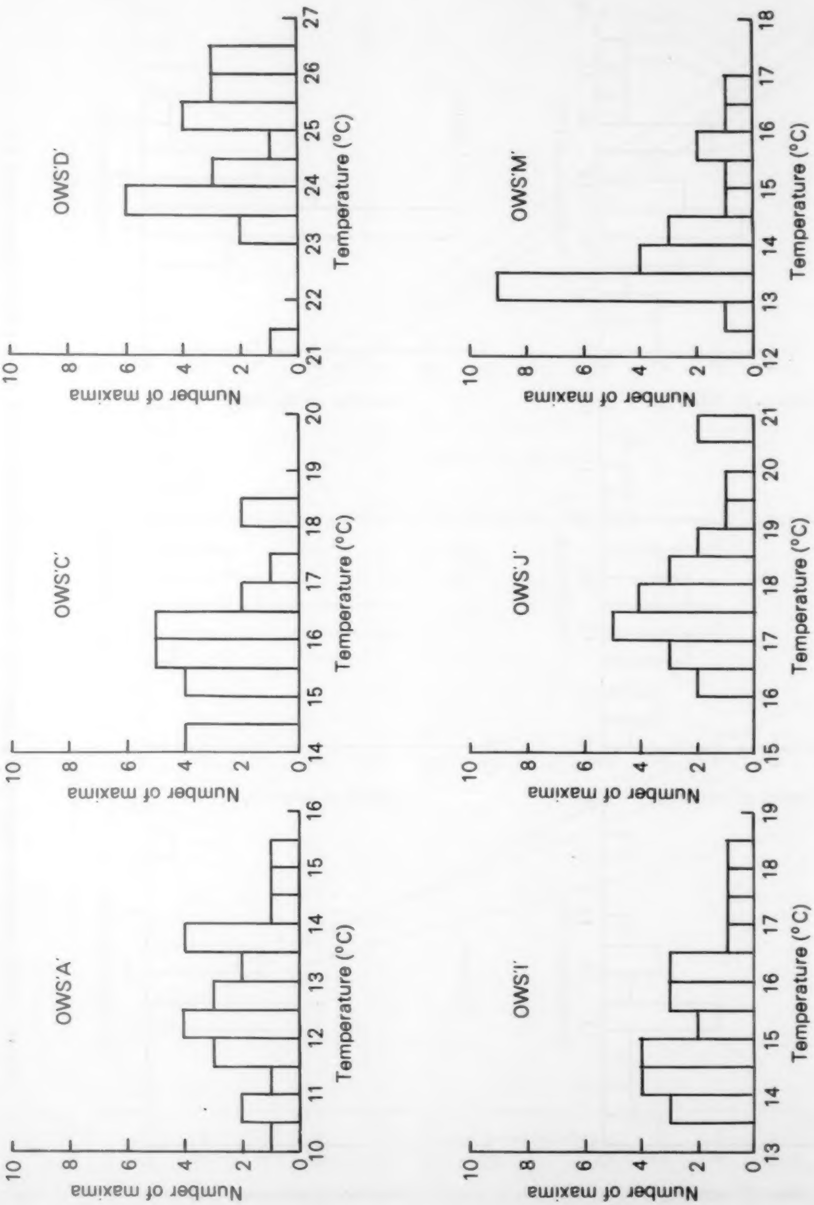

Figure 1. Annual maximum temperatures grouped in 0.5 °C intervals for selected Ocean Weather Stations for the 23-year period 1950–1972.

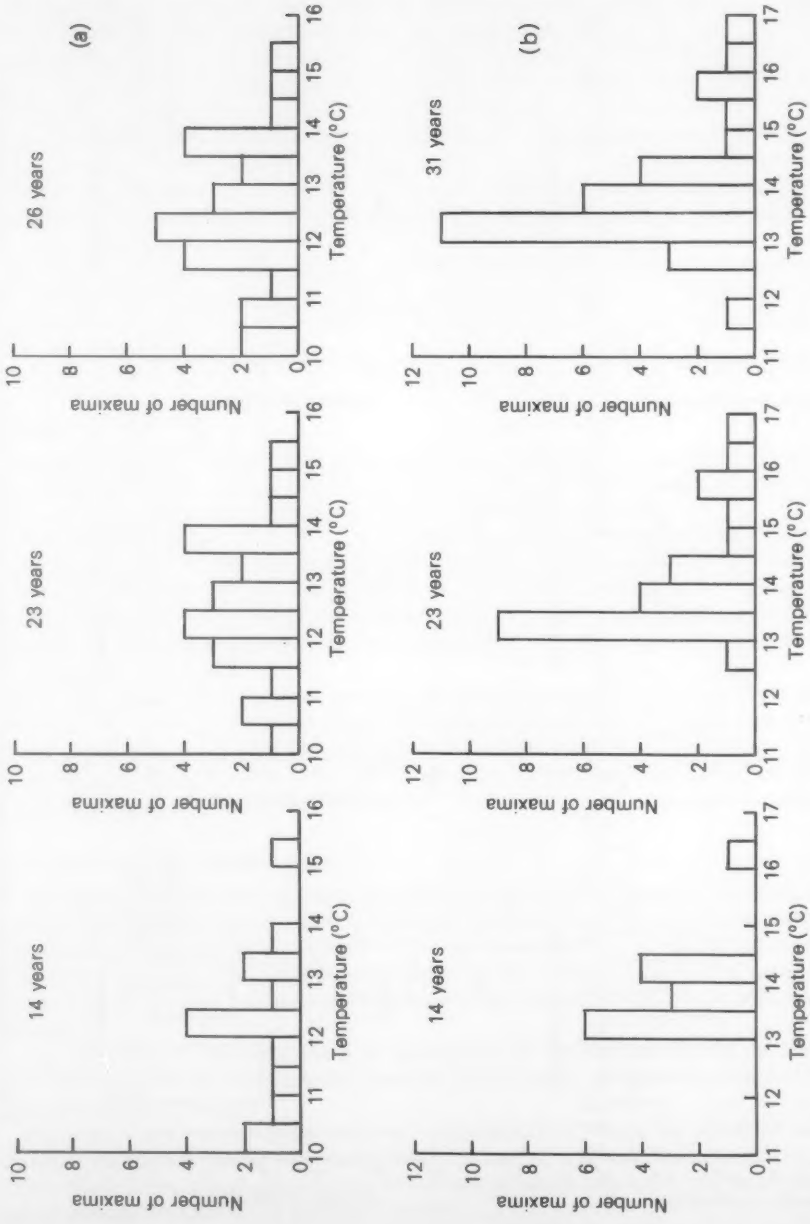

Figure 2. Annual maximum temperatures grouped in 0.5 °C intervals for selected periods for (a) OWS 'A' and (b) OWS 'M'.

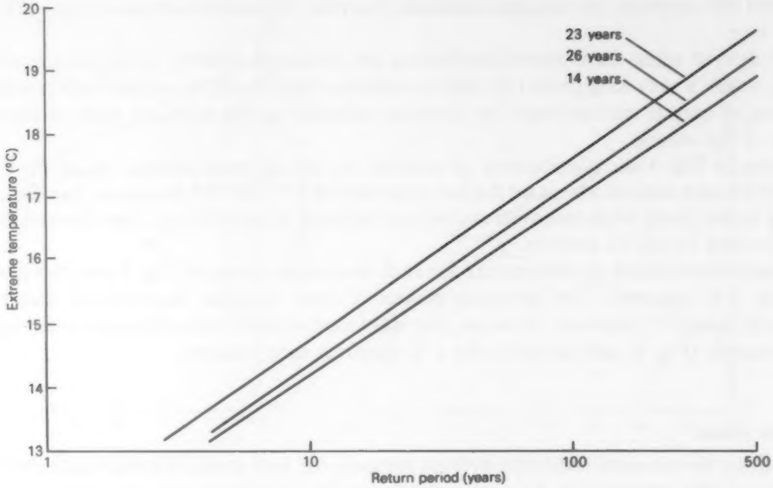

Figure 3. Extreme maximum temperature predicted by Gumbel analyses for OWS 'A' using 14, 23 and 26 years of data.

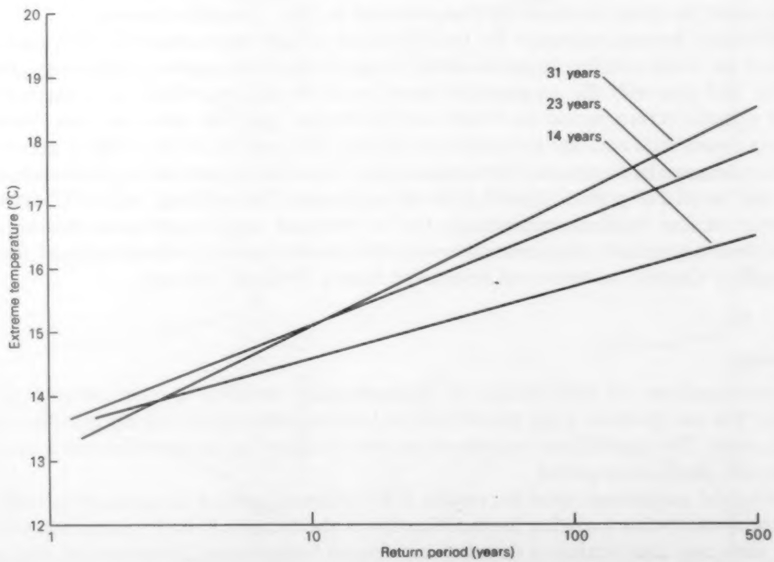

Figure 4. Extreme maximum temperature predicted by Gumbel analyses for OWS 'M' using 14, 23 and 31 years of data.

For OWS 'M', however, the extremes estimated from the 14 years of maxima are quite different from the other two.

Results derived using the Gumbel distribution are obviously sensitive to the sample of data and, therefore, unless a very long period of data is available, they should be treated with caution and the distribution of annual maxima must be examined carefully as this may give some indication of the reliability of the sample.

As shown in Fig. 1 the distributions of maxima for the 23 years covered by all the OWS seem reasonable for each station, except for the low value for OWS 'D' (21 °C). However, this made very little difference to the result when removed and so was included in the analysis. This allowed the same 23 years to be used for all six stations.

Frequency distributions of temperature for each station are shown in Fig. 5 with the temperatures grouped in 1 °C intervals. This grouping produced some irregular distributions which could be smoothed by using 2 °C intervals. However, this was found to make little difference to the results of the Weibull analysis (Fig. 6) and therefore the 1 °C intervals were retained.

3. Extreme values

Fig. 7 shows the extremes estimated by both methods for each station plotted against the log of the return period. This presentation does not actually produce a straight line, but rather a very shallow curve; however, it is a useful representation of the results.

When the Weibull extremes were compared with the Gumbel extremes they were seen to be overestimated for short return periods and underestimated for longer return periods. The terms 'long' and 'short' are used fairly loosely in this connection and vary markedly from station to station depending upon the point at which the curves shown in Fig. 7 actually intersect.

The differences between extremes for various return periods were compared with such statistical properties of the whole distribution as the mean, standard deviation, number of frequency groups in the Weibull fit, and also with the geographical position of the stations. These same factors were also compared with the return period for which both techniques gave the same extremes. None of these direct comparisons indicated any systematic connection. Attempts were also made to derive empirical relationships between two or more of these parameters. None were found that applied to all six stations. Of those that seemed to provide a good fit to the parameters, the resulting 'corrected' extremes were usually poor because small discrepancies in the fit produced large errors in the final result. It was concluded that no systematic relationship between the extremes existed for these data and, therefore, no way in which a 'Gumbel' extreme can be derived from a 'Weibull' extreme.

4. Persistence

The interdependence of observations of meteorological variables is often referred to as 'high' correlation. The real problem is not the correlation between observations but the repetition of records of a single event. This repetition of records of an event is caused by the persistence of a situation over more than one observation period.

If the effect of persistence upon the results is to be investigated it is necessary to remove it and compare the results before and after the modification of the data set. Firstly, it is necessary to define an 'event' in some way and produce a distribution of more 'independent' observations. Unfortunately, there is no easily identifiable phenomenon for temperature that allows the isolation of events and gives a large enough number of observations to be used in a Weibull analysis. Consequently, the method used

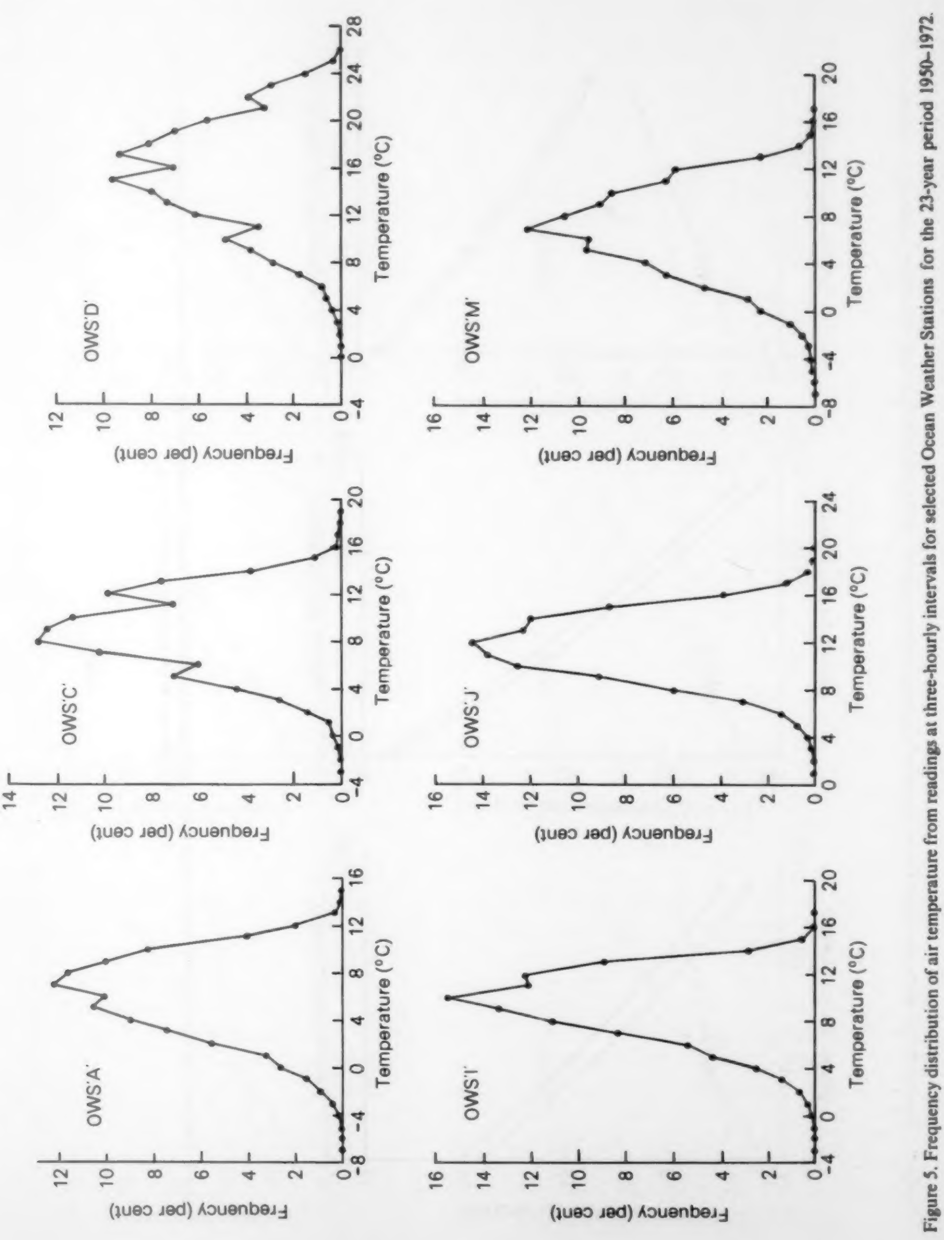

Figure 5. Frequency distribution of air temperature from readings at three-hourly intervals for selected Ocean Weather Stations for the 23-year period 1950–1972.

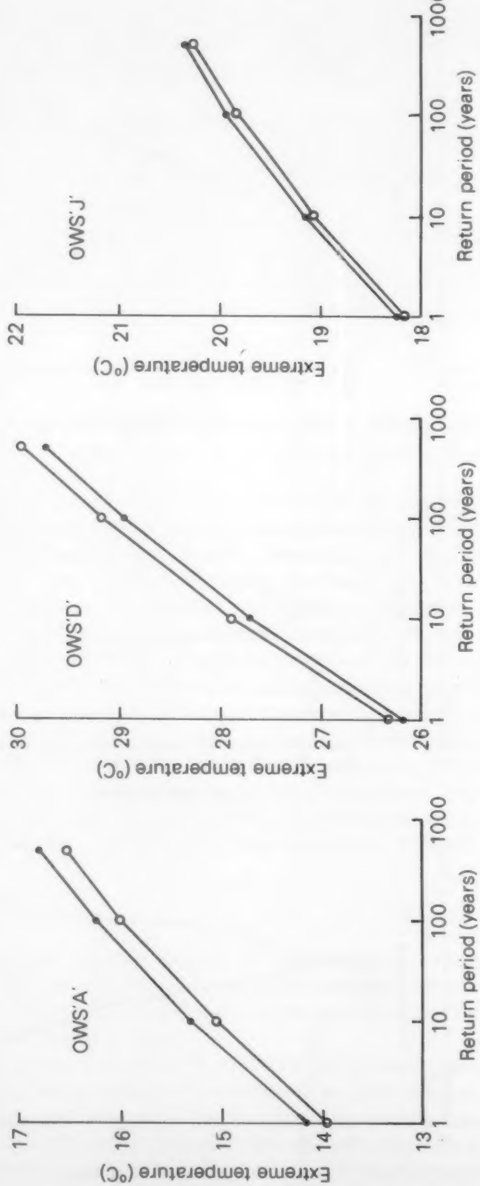

Figure 6. Frequency groups for three-hourly temperature readings for selected Ocean Weather Stations using a Weibull analysis on temperatures grouped at 1 °C intervals ●—● and 2 °C intervals o—o

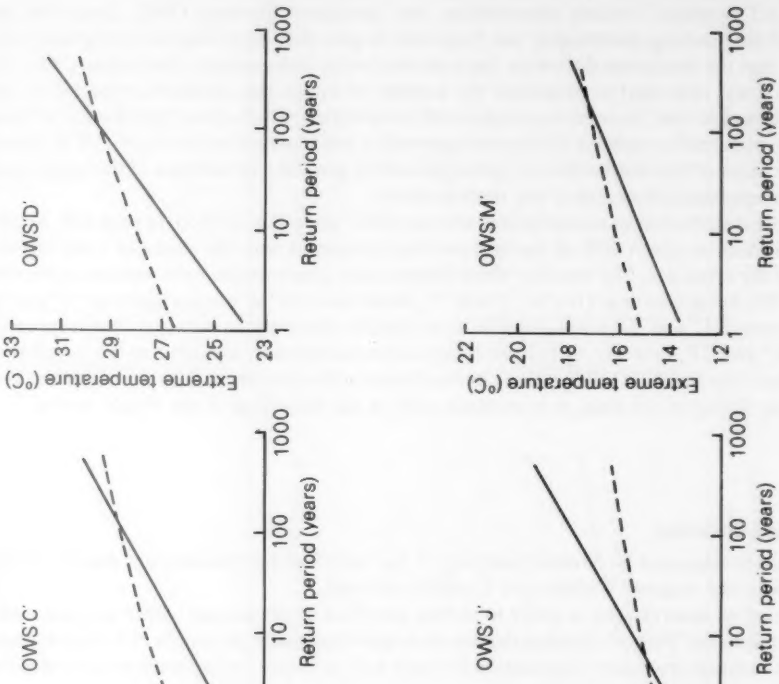

Figure 7. Extreme maximum temperatures for selected Ocean Weather Stations derived using Gumbel and Weibull techniques. (Gumbel — Weibull - - - -).

to define an average event size (in terms of degrees centigrade) and length (hours) was as follows. The difference ΔT between 3-hourly observations was calculated for each OWS. Twice the standard deviation of the resulting distribution was then used to give the size (in degrees centigrade) of a single event such that the minimum difference between successive independent observations was ΔT. The value of ΔT was also used to determine the number of events that would be expected to occur on average each year so that the return periods could be identified. To do this a distribution of 'spells' was constructed, each spell consisting of observations within one standard deviation of ΔT of one another. The median value of this distribution of spells was used to give the best estimate of the length of time for which an independent observation was representative.

Each whole distribution of temperatures was modified using this method, in each case reducing the observation count to about 30% of the original total consistent with the choice of twice the standard deviation as the event size. The time for which independent observations were representative varied for different OWS, being four hours for 'A', 'I' and 'J', three hours for 'M' and six hours for 'C' and 'D'. For each OWS except 'C' and 'D' it was possible to use hourly observations to determine the representative time. For 'C' and 'D', however, only three-hourly observations were available so it is possible that the representative time for these OWS is three or four hours as for the others. The representative time does not affect the fitting of the data, it is involved only in the definition of the return period.

5. Results and discussion

The extremes estimated by Weibull analysis of the modified distributions are shown in Fig. 8 and compared with the original Weibull and Gumbel extremes.

The removal of observations in order to reduce the effect of persistence within the data makes very little difference to the Weibull extremes despite the large reduction in the number of observations. Fig. 9 shows the percentage frequency distribution for each station before and after the reduction in the effect of persistence.

Another modification of the distribution was attempted by identifying observations of separate events. On a plot of temperature against time the 'gradient' at a point (or observation) can be calculated by finding the gradient between the previous observation and the one after it. Where successive gradients changed sign a turning point had been found and the corresponding temperature was considered to be an observation of an independent event.

The resulting distributions were much the same as the unmodified ones, although again the number of observations was considerably reduced. The estimated extremes were slightly different, but the change did not account for the difference between the Weibull and Gumbel extremes.

All meteorological variables are persistent to some extent and temperature is particularly so. There is a correlation not only from observation to observation but also from day to day due to the diurnal variation (rather less marked for temperatures over the sea than on land) and also seasonal variations.

It is not possible to make the data sequence totally independent in a statistical sense, but a positive attempt can be made to make it less dependent by removing values similar in magnitude to those preceding them. This was achieved by imposing an empirical threshold value and discarding any observation within one threshold of the value immediately before it. It was also necessary to adjust the time used in the Weibull analysis for which an observation may be said to be representative.

The remaining events are still dependent, but repeated records of an event should have been removed. The reduction of the number of observations to one third of the original total by this method implies a great change in the distribution, but the Weibull analysis is not significantly altered. This is explained by

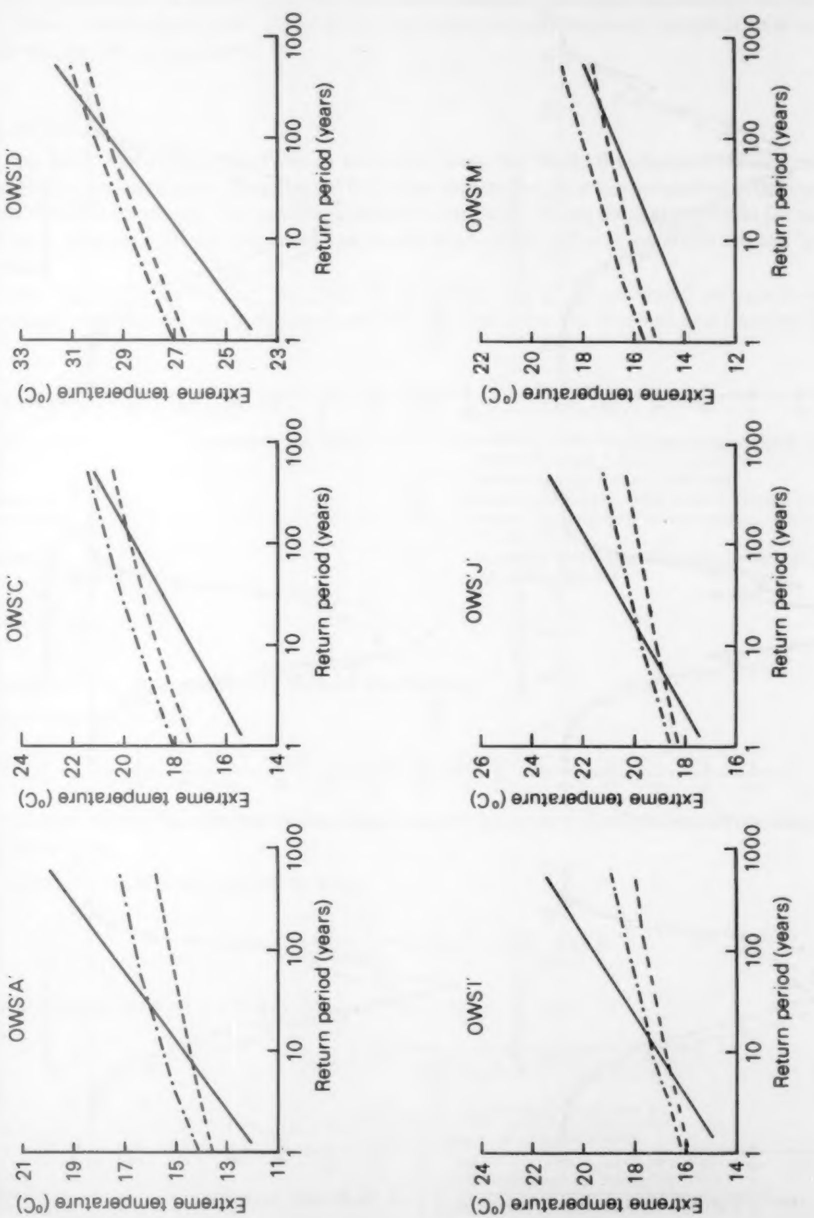

Figure 8. Extreme maximum temperatures for selected Ocean Weather Stations derived using a Weibull analysis on a modified temperature distribution ●—●—● compared with the original Gumbel — and Weibull ---- analyses.

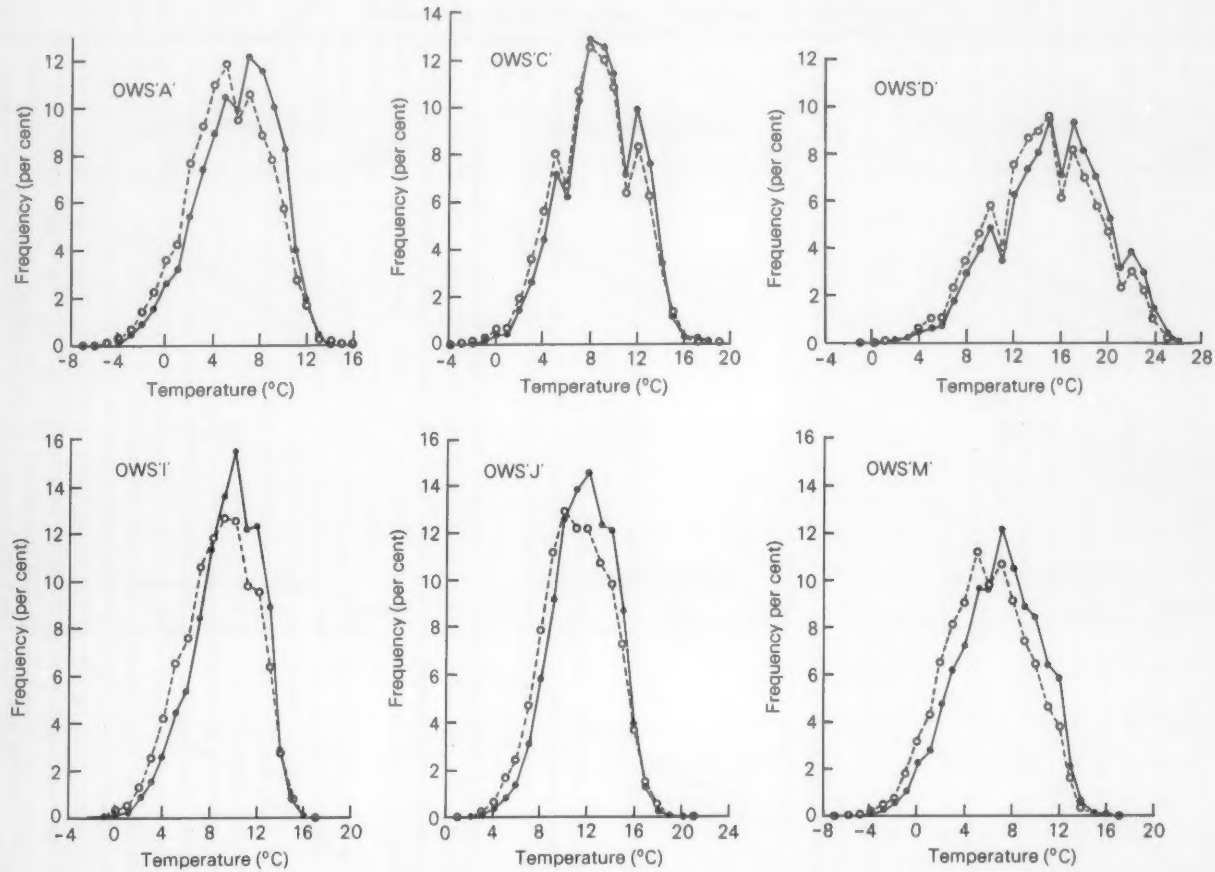

Figure 9. Air temperature distributions for selected Ocean Weather Stations for the 23-year period 1950–1972. Unmodified ●—●, modified to reduce the effect of persistence o—o.

the fact that though the number of observations has changed, the range and shape of the distribution is still similar to its original form. This is to be expected since only repeated records of an event have been removed, not the actual event.

6. Conclusion

It has been confirmed that extremes estimated using the Weibull technique are overestimated for short return periods and underestimated for longer return periods when compared with those estimated by the Gumbel technique. The definition of 'short' and 'long' return period is different for each location and there appears to be no consistent systematic relationship between extremes derived from the two methods.

It has also been shown that the effect of persistence upon the estimated extreme is insignificant compared with the difference between extremes derived from the Weibull and Gumbel techniques.

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Appendix — The three-parameter Weibull distribution

Distribution function:

$$F(x) = 1 - \exp\left\{-\left(\frac{x - x_0}{B}\right)^A\right\} \quad .. \quad .. \quad .. \quad .. \quad .. \quad .. \quad (A.1)$$

This distribution function is fitted to the cumulative frequency distribution of the whole spectrum of 'available' data.

Expression (A.1) is rearranged to give

$$\ln\ln\left(\frac{1}{1 - F(x)}\right) = A \ln(x - x_0) - A \ln B \quad .. \quad .. \quad .. \quad .. \quad .. \quad (A.2)$$

which is in the form of a straight line, $y = mX + c$.

$$F(x) = \frac{\text{number of observations below limit } x}{\text{total number of observations}}$$

so $$\{1 - F(x)\} = \frac{\text{number of observations above } x}{\text{total number of observations}}$$

then $$y \equiv \ln\ln\left(\frac{\text{total number of observations}}{\text{number of observations above } x}\right). \quad .. \quad .. \quad (A.3)$$

A straight line is fitted using various values of x_0 until the best line is found. A, B and x_0 are the three parameters of the best fit.

The resulting Weibull distribution is then assumed to have the same three parameters, however many observations are made, so that it can be used to estimate extremes for any return period.

In estimating the extreme value, y is redefined to be used in the expression

$$\text{(extreme)} = \exp\left(\frac{y + A \ln B}{A}\right) + x_0 \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad \text{(A.4)}$$

which is a rearrangement of expression (A.2).

The extreme value required is that value likely to be exceeded at least once in the given return period. The 'number above x' in expression (A.3) is therefore 1. The total number of observations in a given return period depends on the 'representative time' of the observations used in the Weibull fit.

When using the Weibull method, the distribution of available data is assumed to be representative of the whole population. Obviously the more observations there are the more likely the distribution is to be representative of the whole population. Therefore, observations made at hourly intervals would be likely to produce a better sample than observations made at three-hourly intervals over the same period. However, provided that the observations are all made in the same way the representative time will be the same for both distributions, and over a long enough period the percentage frequency distributions would be identical.

Very often the representative time chosen is the interval between observations. This means that with two distributions of, say, air temperatures, one with observations made at hourly intervals and one at three-hourly intervals, but both taken over the same period which was long enough to produce identical percentage frequency distributions, the extremes estimated would be different. This is because in one year there would be 8760 observations made at hourly intervals and only 2920 at three-hourly intervals.

The true representative time is not the interval between observations but the time for which each observation is representative of the conditions.

For air temperatures over the sea the representative time was three hours with the event length as chosen. For OWS 'I', 'J' and 'M' over the period 1962–75 (14 years) two distributions of air temperatures were constructed, one of hourly and one of three-hourly observations. Table A.I shows the resulting percentage frequency distributions for OWS 'I'. The two distributions are almost identical. Table A.II shows the results of the Weibull fit and Table A.III the extremes estimated for the 10- and 50-year return periods using observation interval and the three-hour representative time. The extremes are very similar when using the three-hour representative time for OWS 'I' as are 'J' and 'M' (not shown). Using the observation interval of one hour for the distribution of hourly observations gave higher estimates. The difference is not great in this case, but if the true representative time was shorter than the observation interval the extremes would be underestimated and this is much more serious.

This is probably so for wind speeds. Wind speed is very variable and is generally measured over some fixed time interval, say one hour, and the resulting value is the average wind speed over that time, i.e. hourly mean wind speed. In this case the representative time would be one hour and there would be 24 possible observations per day, whatever the observation interval. For the 10-minute means using the same argument there would be six possible 10-minute wind speeds every hour, and for gusts, assuming 3 seconds, 1200 every hour. Obviously the argument cannot be extended without limit. One 10-minute wind speed and the next will be correlated, as will one 3-second gust and the next. The representative time will be somewhere between the averaging time and one hour, depending upon the scale of the meteorological phenomenon concerned. So the best solution is to do some analysis to determine the actual representativeness of the observations in a manner similar to that done for the air temperatures.

Table A.I. *Percentage frequencies of air temperatures from OWS 'I' for hourly and three-hourly observations*

Temperature (°C)	Hourly observations	Three-hourly observations
−2	0.01	0.01
−1	0.04	0.05
0	0.08	0.08
1	0.23	0.23
2	0.71	0.72
3	1.48	1.52
4	2.60	2.62
5	4.28	4.17
6	5.99	6.02
7	9.00	8.97
8	11.48	11.61
9	14.54	14.50
10	16.09	16.08
11	12.65	12.62
12	11.49	11.52
13	6.89	6.82
14	1.94	1.97
15	0.41	0.39
16	0.09	0.09
17	0.02	0.02
Total number of observations	113 011	37 734

Table A.II. *Results of Weibull fit to temperature distributions from OWS 'I' for hourly and three-hourly observations*

	Hourly observations	Three-hourly observations
Gradient (A)	6.29	6.40
Intercept (A ln B)	−17.06	−17.45
Third parameter (x_o)	−5.30 °C	−5.55 °C

For explanation of A, A ln B and x_o see expression A.2.

Table A.III. *Temperature extremes (°C) estimated from hourly and three-hourly temperature distributions from OWS 'I'*

Distribution	Representative time	Once in 10-year extreme	Once in 50-year extreme
3-hourly	3 hours	16.43	16.93
Hourly	1 hour	16.85	17.33
Hourly	3 hours	16.52	17.03

For wind speeds work is to be done using DALE (digital anemograph logging equipment) data to try to establish a general relationship between averaging time and representative time. It is clear that averaging time alone is not the answer although in the absence of anything else it may be best to use it.

When averaging time or observation interval must be used it is important to remember that the extremes estimated are based on a sample of a particular kind of measurement made at the specified reporting interval.

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The Ben Nevis Meteorological Observatory 1883–1904

Part 1. Historical background, methods of observation and published data

By Marjory G. Roy

(Meteorological Office, Edinburgh)

Summary

This article contains: a brief history of the Ben Nevis Observatory and the corresponding low-level observation sites at Fort William close to the foot of the mountain; a description of the observational routine and the resulting data, both published and unpublished.

1. Introduction

October 17 1983 marks the centenary of the opening of a high-level meteorological observatory on the summit of Ben Nevis, 1344 m (4407 ft), the highest mountain in the British Isles. The hourly weather observations which were made there over a period of nearly 21 years were published in detail in the *Transactions of the Royal Society of Edinburgh* and comprehensively analysed at the time, notably by Alexander Buchan (the Secretary of the Scottish Meteorological Society) and by members of the Observatory staff. However, to a large extent the observations appear to have been overlooked by those carrying out research in more recent times into conditions in the lower layers of the atmosphere. In the light of the great advances in meteorological knowledge that have occurred in the intervening years there is considerable scope for the reuse and reinterpretation of these (generally) extremely high-quality data. It is hoped that some, at least, of these data will be put into computer compatible form*.

2. Historical background

In an article published on the occasion of the 50th anniversary of the closing of Ben Nevis Observatory, Paton (1954) gives a graphic and comprehensive description of the planning, building and running of the Observatory. Further details can be found in Buchan (1890) and Kilgour (1905).

Briefly, the Observatory was proposed, established and run principally by the Scottish Meteorological Society, which was founded in 1855 and was incorporated with the Royal Meteorological Society in January 1921. The Scottish Meteorological Society had, from its inception, set up and maintained, in Scotland, a network of climatological stations manned by voluntary observers. The network continues today as part of the UK voluntary cooperating climatological network. The Edinburgh Climatological Office, formerly headquarters of the Scottish Meteorological Society, became part of the Meteorological Office in 1921 and still administers the Scottish climatological stations.

The enterprise of setting up the Observatory was proposed in 1877 by the Scottish Meteorological Society on the basis that the location of Ben Nevis close to the western seaboard of Scotland, and also frequently close to the storm tracks of Atlantic depressions, would make the observations of particular

*In June 1983 a Manpower Services Commission Community Project started work on putting the Ben Nevis and Fort William observations into computer compatible form. The data will be available on magnetic tape through the Scottish Centre of the Royal Meteorological Society.

interest. Early in 1883 a public appeal was launched and a sum of £4 000 was subscribed within a few months with Queen Victoria heading the subscription list. During the summer of 1883 the bridle path to the summit and the Observatory building were constructed, the Observatory being formally opened on 17 October 1883 by Mrs Cameron Campbell, the owner of the estate of Callart which included the western half of Ben Nevis. The Observatory was managed by a committee consisting of the Council of the Scottish Meteorological Society and representatives nominated by the Royal Societies of London and Edinburgh.

Regular hourly observations commenced on 28 November 1883, the three observers taking 4-hourly watches by day and 8-hourly watches by night. However, during the first winter the build up of snow became so great that an access tunnel 30 ft long and with a rise of level of 12 ft had to be dug. During bad weather it was impossible to keep this tunnel open and observations were interrupted. In order to overcome this problem a 30 ft-high tower was added in the summer of 1884 to provide an exit door in winter, and the observatory building was enlarged.

It was considered essential to provide a nearby low-level comparison station at Fort William 4 miles away and the schoolmaster at the public school there was responsible for making observations five times per day. During July 1890 a low-level observatory, see Fig. 1, equipped with autographic instruments, was opened in Fort William. Comparisons were made between the observations at the school and at the low-level observatory.

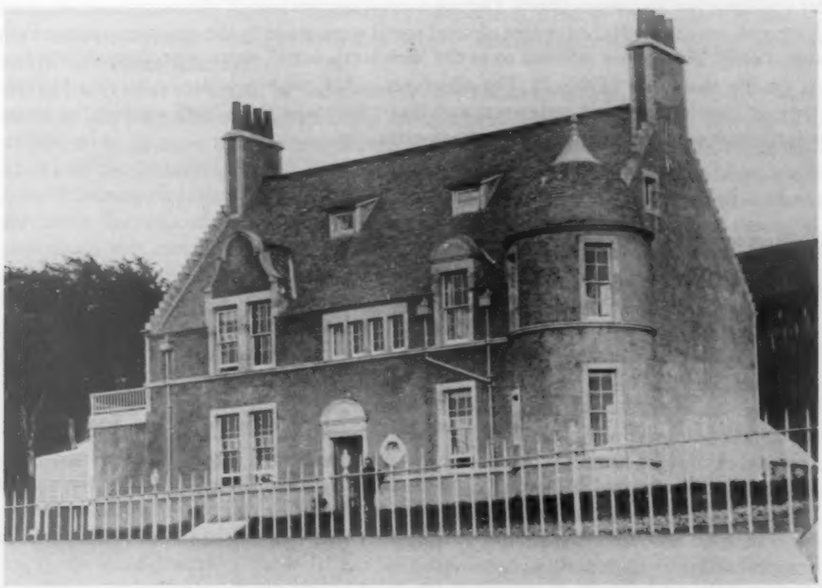

Figure 1. Fort William Observatory

From the start it had been hoped that government funds would be made available to support the running of Ben Nevis Observatory, but the Meteorological Council was only willing to make a grant of £100 per annum for the receipt by the Meteorological Office of occasional telegraphic reports and of copies of the hourly observations. (For the low-level observatory, which conformed more closely to their expectations of how an observatory should be run and equipped, the Meteorological Council provided autographic instruments and a grant of £250 per annum.) As can be imagined, the cost to a learned society of running such an enterprise with negligible financial support from government sources was very great, even though the Superintendent received only a small nominal salary and his two assistants small emoluments. It was only thanks to a number of generous, mainly Scottish, benefactors that the Observatory was able to continue to function until 1904, when it was closed after the noon reading had been made on the first of October.

3. Weather observations at Ben Nevis Observatory

As a result of observations made by observers who climbed the mountain daily from Fort William during the summers of 1881, 1882 and 1883 it was clear to the Council of the Scottish Meteorological Society that it would be impossible to maintain an observatory of the standard pattern of the time with photographically recording instruments. Even in summer the rate of build-up of rime was frequently so great that instrument shelters became clogged, preventing proper exposure of the thermometers. Anemometers were incapable of operation except when the temperature was above freezing point.

Consequently it was decided that observations would have to be made manually. Duplicate screens and rain-gauges were provided so that one could be brought inside to be thawed out and de-iced while the other was used for the observations. During a considerable part of the year the anemometer could not operate and, consequently, estimates of wind speed were made by the observers using a variation of the Beaufort scale, hereinafter referred to as the 'Ben Nevis scale', more appropriate to the high winds observed on the mountain (Table I). The observers could, with practice, achieve a high degree of consistency in their wind speed estimates, and they calibrated these both against the instrumental records in the summer and against each other's estimates.

Table I. *Comparison of Ben Nevis and Beaufort wind scales*

Force	Mean wind speed (knots)		Mean wind speed (miles per hour)	
	Ben Nevis	Beaufort	Ben Nevis	Beaufort
0	<5	0	<6	0
1	5	2	6	2
2	10	5	12	5
3	18	9	21	10
4	26	13	30	15
5	34	19	39	21
6	43	24	49	28
7	52	30	60	35
8	63	37	72	42
9	(73)	44	(84)	50
10	(84)	52	(97)	59
11	(97)	60	(112)	68
12	(113)		(130)	

Bracketed values are estimates — no comparison with an instrumental record was available.

Once the tower to the Observatory had been built during the summer of 1884, interruptions to the hourly routine generally only occurred during periods of very high winds when it was unsafe for the observers to leave the shelter of the building. However, from August 1890 thermometers were mounted in a screen attached to the tower, with stems projecting through holes in the wall so that they could be read in safety.

Details of the methods employed in making the meteorological observations, and the problems encountered, are given below.

3.1 *Atmospheric pressure*

Hourly observations of pressure were made at Ben Nevis Observatory with two Fortin barometers that had been calibrated at Kew. Readings were corrected for instrumental error and to 32 °F (0 °C), but published values were not corrected to mean sea level thus enabling research workers to examine in detail the relationships between the hourly values of pressure at Ben Nevis Observatory (1344 m, 4407 ft above mean sea level) and those at the same time at Fort William Observatory (barometer height 13 m, 42 ft above mean sea level) 4 miles away. At the latter site pressure observations were obtained from a photographic barograph and the readings were corrected to 0 °C and reduced to mean sea level using tables based on Laplace's formula i.e. the hydrostatic equation. Prior to the opening of Fort William Observatory pressure readings were made five times a day (08, 09, 14, 18 and 21 GMT) at the school at Fort William (barometer height 10 m, 33 ft above mean sea level) using a Board of Trade pattern barometer. These were also corrected to 0 °C and reduced to mean sea level. The unit of pressure employed was the 'inch of mercury' (inHg) where 1 inHg = 33.863 mb; all pressures quoted in the present paper have been converted to millibars for the convenience of the modern reader.

At Ben Nevis Observatory and Fort William School, Richard aneroid barographs were used as a check on the barometer readings.

A 'table of corrections for height' to reduce the barometric observations at Ben Nevis Observatory to mean sea level was prepared by Buchan using the synchronous observations at Ben Nevis and Fort William. This table assumed that the temperature of the air in between was the arithmetic mean of the temperatures at the Observatory and Fort William. However, when departures from normal were investigated it became clear that when high winds prevailed at the summit the pressure observed inside the Observatory was reduced owing to the airflow over the building. Consequently an amended table of mean corrections was computed (Buchan 1890) using only those occasions on which the wind at the Observatory was less than 30 mph (26 knots). This correction table is published as Table VIII of the Introduction to Volume 34 of the *Transactions of the Royal Society of Edinburgh.* (Studies of the difference in calculated mean-sea-level pressure for Ben Nevis and Fort William under conditions that exclude occasions of strong winds at the summit are referred to later.)

The effects of both wind speed and wind direction on the mean-sea-level pressure differences (calculated using the mean correction table) between Ben Nevis and Fort William were studied in detail by Buchan (1902). (At the relatively sheltered site at Fort William winds exceeding 30 or even 20 mph were rare occurrences.) When all wind directions were combined the mean depressions shown in Table II were obtained. At wind speeds in excess of 57 mph (52 knots) the barometric depression exceeded 1.7 mb and reached almost 6 mb with the highest wind speed recorded.

However, it was evident to Buchan that the pressure diminution observed differed considerably according to the wind direction. Table III has been converted to present-day standard meteorological units of millibars from Buchan's analysis of 10 months' data for the high- and low-level observations, supplemented by use of some of the pairs of data between the high-level observatory and the observations made five times a day at the school in Fort William. Buchan noted that for certain wind

Table II. *Depression of barometer at Ben Nevis Observatory for different wind speeds (all wind directions combined) adapted from Buchan (1902)*

Wind speed on Ben Nevis scale	0	1	2	3	4	5	6	7	8	9	10	11	12
Equivalent mean wind speed in knots	<5	5	10	18	26	34	43	52	63	73	84	97	113
Barometric depression in millibars	<0.1	0.1	0.2	0.3	0.5	0.9	1.2	1.7	2.4	3.5	4.3	5.1	5.8

directions speeds in excess of 30 mph had not been observed on Ben Nevis during the period January 1885 to May 1891 (see Table III), and that speeds in excess of 72 mph were confined to winds between east-south-east and south-east. The observatory was situated on the edge of a 550 m (1800 ft) cliff, immediately to the north of the building. Visual observations confirmed that the speed of clouds moving from the north, at only a small height above the mountain, were considerably greater than the wind speeds observed manually and instrumentally at the observatory. Table III shows that for wind speeds of less than force 4 the diminution of pressure was small for wind directions from south-east through south and west to north-west, but that it was very much greater for winds blowing from the other half of the compass. Buchan's conclusion was that 'the depression of the barometer ... clearly indicates the formation of a restricted space of low pressure outside and around the building of the Observatory'.

Thus care must be taken with the interpretation of the barometric pressure, including hourly pressure changes, during periods of strong, or even moderate, winds (from certain directions), particularly since the barometer 'pumps' violently at these times. The barometer readings were taken at the point which the mercury was seen to rise to, and hold steady at, briefly.

3.2 *Stevenson screen observations — dry- and wet-bulb temperatures*

During the summer months the dry- and wet-bulb thermometers at the Ben Nevis Observatory were placed in an ordinary Stevenson screen with their bulbs 4 ft (1.2 m) above the surface of the ground, which consisted of broken rocks without any vegetation. However, during the winter the thermometers were placed in a slightly smaller screen of similar pattern attached to a ladder-like stand so that the screen could be raised or lowered as the depth of snow varied (see Fig. 2), and thus the thermometers kept between three and five feet above the surface. When the louvres of a screen got choked with snow or rime it was removed bodily to the observatory to be thawed out and replaced by a duplicate with fresh thermometers. Self-registering thermometers were not used for maximum and minimum temperatures. During very stormy weather when it would have been dangerous to go outside, the temperature was read, from August 1890 onwards, from a screen attached to the wall of the Observatory tower. The thermometers could then be read without going outside and it was found that with wind speeds of force 9 or more (Ben Nevis scale) there was little difference between the tower and Stevenson screen observations.

Care was taken to ensure that if the temperature was below 0 °C the 'wet bulb' was coated with ice, i.e. was a true 'ice bulb'. Since the usual condition on Ben Nevis was one of a saturated atmosphere, the dry bulb quickly became coated with water in summer and water or ice during most of the rest of the year. As a result the 'dry bulb' frequently read lower than the wet bulb (not only in conditions when the ice bulb temperature *could* be slightly higher than the dry bulb) since it responded more quickly to temperature changes than the latter. All published values of dry- and wet-bulb temperatures were 'as read', without correction for such problems.

Table III. *Mean depression of barometer (in millibars) at Ben Nevis Observatory for different wind directions and wind speeds (Ben Nevis scale) adapted from Buchan (1902)*

Force								Wind direction									
	N	NNE	NE	ENE	E	ESE		SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0	0.3	0.4	0.5	0.4	0.4	0.3		0.2	0.1	0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.2
1	0.3	0.4	0.4	0.5	0.2	0.0		−0.1	−0.1	−0.1	−0.0	−0.0	0.0	0.0	0.1	0.2	0.3
2	0.7	0.8	0.9	0.8	0.5	0.3		0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.5
3	0.9	1.2	1.3	1.0	0.7	0.4		0.3	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.5	0.7
4	1.1	1.5	1.6	1.5	1.1	0.8		0.5	0.3	0.2	0.1	0.2	0.2	0.2	0.1	0.7	1.1
5	1.8	1.8	1.8	–	–	0.9		0.8	0.6	0.4	0.3	0.3	0.4	–	–	–	–
6	2.2	–	–	–	–	1.2		1.2	0.9	0.7	0.6	0.6	–	–	–	–	–
7	2.8	–	–	–	–	1.9		1.8	1.5	1.5	–	–	–	–	–	–	–
8	–	–	–	–	–	2.7		2.4	2.0	–	–	–	–	–	–	–	–
9	–	–	–	–	–		3.6*		–	–	–	–	–	–	–	–	–
10	–	–	–	–	–		4.3		–	–	–	–	–	–	–	–	–
11	–	–	–	–	–		5.1		–	–	–	–	–	–	–	–	–
12	–	–	–	–	–		5.8		–	–	–	–	–	–	–	–	–

*Combined directions ESE and SE

Although the usual state of the atmosphere was one of saturation, there occurred also spells of weather when very low humidities were observed, sometimes for a considerable number of hours and sometimes alternating rapidly with high humidities. These very low humidities were associated with anticyclonic conditions. The hygrometric tables in use in the United Kingdom at the time were those of Glaisher, but since these did not extend to the observed conditions of dry- and wet-bulb temperatures, it was necessary to extrapolate the tables from his factors or make use of the formulae published by Apjohn, August or Regnault. The daily sheets of hourly data that were completed at the time (and are held in the Archives of the Meteorological Office, Edinburgh) contain values of relative humidity and dew-point which were derived from an extension of Glaisher's tables. However, a series of experiments carried out on Ben Nevis by Dickson in 1885 and Herbertson (with the assistance of the observers) in 1892 and 1893 showed that Glaisher's tables gave values of dew-point that were too low for temperatures below about 35 °F (1.7 °C) and too high for temperatures above 1.7 °C, though the latter differences were less marked. It is very fortunate that the published observations were of dry- and wet-bulb temperatures and not of dew-point. (Herbertson (1905) also discussed the problems of measuring temperatures in a Stevenson screen under calm, cloudless conditions and compared the readings with those of aspirated psychrometers.)

At the school in Fort William, readings were taken five times a day (08, 09, 14, 18 and 21 GMT) from dry- and wet-bulb thermometers in a Stevenson screen, and self-registering thermometers were read and reset daily at 18 GMT for the maximum thermometer and 09 GMT for the minimum thermometer. These readings covered the period from December 1883 to 31 December 1891.

The Fort William Observatory (located about 150 yards from the school) came into operation on 1 August 1890 and the hourly temperatures were obtained from traces of photographic dry- and wet-bulb thermometers placed in a large louvred screen on the north wall of the observatory. The louvred screen also contained dry- and wet-bulb thermometers read by eye at 09, 10, 12, 14, 16, 21 and 22 GMT, and

Figure 2. Ben Nevis Observatory in winter.

maximum and minimum thermometers read and reset at 22 GMT. (These data were *not* published in the *Transactions of the Royal Society of Edinburgh.*) In addition similar readings of temperature were made in a Stevenson screen located on a grass plot to the south of the observatory in a position freely exposed to sun and wind; these have been published.

Omond (1894) carried out a comparison of the differences in maximum and minimum temperature between the schoolhouse Stevenson screen and observatory Stevenson screen for each month of the year in 1891, and between the schoolhouse Stevenson screen and the photo-thermograph (dry bulb, wet bulb and maximum and minimum temperatures extracted from the trace) from August 1890 to December 1891. (Tables IV and V).

Table IV. *Difference (°F) between Fort William School and Fort William Observatory Stevenson screen temperatures for 1891. Positive values indicate schoolhouse temperatures higher than those at the observatory.*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Maximum	−0.5	−0.1	+0.1	+0.7	+1.2	+2.2	+1.4	+1.1	+0.8	−0.8	−0.4	−0.4	+0.4
Minimum	+0.5	−0.1	+0.4	−0.8	−0.2	−1.0	−0.8	−0.6	0.0	−0.4	−0.1	−0.9	−0.3
$\frac{\text{Maximum + Minimum}}{2}$	0.0	−0.1	+0.2	0.0	+0.5	+0.6	+0.3	+0.2	+0.4	−0.6	−0.2	−0.6	+0.1

Table V. *Difference (°F) between Fort Willam School Stevenson screen temperatures and Fort William Observatory photo-thermograph temperatures. Positive values indicate schoolhouse temperatures higher than those at the observatory. (Aug. 1890 – Dec. 1891).*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Maximum	+0.2	+0.7	+1.4	+1.8	+1.6	+2.9	+1.5	+1.8	+1.8	+1.3	+0.5	+0.2	+1.3
Minimum	−1.0	−1.1	−0.9	−1.6	−1.6	−1.9	−1.5	−1.3	−1.0	−1.4	−1.3	−1.5	−1.3
$\frac{\text{Maximum + Minimum}}{2}$	−0.4	−0.2	+0.2	+0.1	0.0	+0.5	0.0	+0.2	+0.4	0.0	−0.4	−0.6	0.0

3.3 *Wind*

A modified Robinson hemispherical cup anemometer was mounted 5 ft (1.5 m) above the roof of the tower, 18 ft (5.5 m) above the roof of the main part of the observatory and about 32 ft (9.8 m) above ground level. It had four cups. The records were obtained as the mean wind speed in miles per hour from a counter, the number of revolutions being read hourly. However, the anemometer could only be used when the temperature was above freezing point, so the instrumental records of wind speed were confined to the summer months, mainly June to September.

Throughout the year wind direction and force were estimated each hour by the observer standing on the flat roof of the observatory, using the Ben Nevis scale (Table I). Equivalent wind speeds for force 9 and above are rough approximations only.

At the school in Fort William the direction and force of the wind were estimated at 09 and 21 GMT daily, during the period 1883 to December 1890. Wind speed and direction were also estimated at the observation hours at Fort William Observatory, but were not published. They are, however, available in the observers' notebooks (held at the Meteorological Office, Edinburgh).

In the publications (*Transactions of the Royal Society of Edinburgh*) a range of wind speed was given for each observation and this provides a useful guide to the 'gustiness' of the wind.

3.4 *Cloud*

The species, and amount of cloud on the scale 0 to 10, were noted for each hour. A fog symbol was used to indicate that the summit was covered by fog or mist, i.e. the sky was obscured. At Fort William, cloud observations were made at the standard reporting hours at both the school and the observatory.

3.5 *Rain*

Five-inch rain-gauges with their rims one foot above the ground were used on Ben Nevis, with one gauge being brought inside each hour for measurement, being replaced outside by a similar one. It must be accepted that with the frequent occurrence of strong winds, particularly during periods of precipitation, the Ben Nevis gauges were very overexposed and the catch consequently less than that which would have been received at ground level. Consequently, the absolute values of rainfall are suspect, and the data can only be regarded as indicating periods of slight, moderate or heavy precipitation. During snowfall with strong winds it is likely that much of the potential catch was blown past the gauge.

The Superintendent of the Observatory, R. T. Omond, recognized the limitations in the use of the rain-gauges in such an exposed situation (Omond 1889) and deduced the wind flow over the gauges from observations of ice-crystal deposition from drifting fog.

A 5-inch gauge was also used at the school at Fort William and read at 09 GMT, but at the Fort William Observatory hourly rainfall was obtained from a Beckley self-recording rain-gauge, with rim 20 inches (51 cm) above ground and diameter 11.3 inches. During periods when the precipitation was of snow daily totals only were given.

3.6 *Sunshine*

Sunshine was recorded with Campbell–Stokes sunshine recorders at both the Ben Nevis and Fort William Observatories. At the latter the hills surrounding Fort William considerably reduced the possible sunshine at all seasons of the year when compared with the open horizon on Ben Nevis.

Published values for the hourly sunshine values referred to Greenwich Mean Time up to 31 December 1890 at Ben Nevis Observatory, but thereafter were in Local Mean Time. At Fort William Observatory they were in Local Mean Time throughout. The amounts entered under each hour were the totals recorded in the 60 minutes ending at the hour.

3.7 *Other observations*

Visibility was recorded using a scale from 0 to 4, with a value 0 when the summit of Ben Nevis alone could be seen, ranging up to 4 when Barra Head, Paps of Jura, Moray Firth, etc. could be seen. However, problems arose since the densest haze layer often lay below the level of the Observatory, though it could rise up and envelope it during the middle part of the day. The term 'mist' was used for a very wet fog and 'fog' for a comparatively dry fog.

The observers noted the occurrences of different types of 'weather'. Among these were the various forms of precipitation, including freezing rain which they called 'silver thaw'. This was of fairly common occurrence with 198 cases being reported in the six years 1885–1890 (Mossman 1893). The mean depth of snow was recorded daily whenever it lay at the summit of the Ben.

The occurrence of thunderstorms was noted; as also was that of 'St Elmo's Fire', normally only seen in the winter months and during the night owing to the feebleness of the light emitted. It was, however, occasionally heard in the daytime.

Various optical phenomena such as haloes, glories, zodiacal light, aurorae, etc. were described in detail in the observatory log-book and measurements made of their appearance.

The Observatory was used as a location for a number of special experiments. For example, a series of measurements of dust particles in the atmosphere were made using an Aitken dust counter (Aitken 1902). Both Dickson and Herbertson carried out important researches on hygrometry at low temperatures and low humidities. These were referred to earlier.

4. Published data

Volumes 34, 42, 43 and 44 parts I and II of the *Transactions of the Royal Society of Edinburgh* contain the greater part of the observed data from the Ben Nevis and Fort William Observatories and from the school at Fort William. The form of publication is one of separate tables of the hourly values of each individual element, apart from air temperature where dry bulb and wet bulb are presented side by side. For the three sites the published data comprise the following:

Ben Nevis Observatory 28 November 1883 to September 1904

Hourly values of:

Pressure at station height (1344 m) and 0 °C in inches of mercury;
Dry-bulb and wet-bulb temperature in degrees Fahrenheit;
Direction and force of the wind (wind direction is given in terms of the 16 principal points of the compass and wind as a range of forces on the Ben Nevis scale);
Mean hourly wind speeds for the periods in the summer when the anemometer was in operation;
Rainfall in inches;
Sunshine in minutes from February 1884 to December 1887, and in fractions of an hour from January 1888 to September 1904; and
Amount of cloud in tenths (or occurrence of mist or fog).

The log-book comments are also printed.

Fort William Observatory August 1890 to September 1904

Hourly values of:

Pressure reduced to mean sea level and 0 °C in inches of mercury, obtained from photo-barograph traces;
Dry-bulb and wet-bulb temperatures in degrees Fahrenheit read from the photographic thermometer records;
Rainfall in inches; and
Sunshine in fractions of an hour.

Tables are also given for:

Stevenson screen values of dry-bulb and wet-bulb temperatures read at 09, 10, 12, 14, 16, 21 and 22 GMT; *
Amount of cloud at 09, 10, 14, 21 and 22 GMT; and
Maximum and minimum temperatures for the 24 hours ending at midnight for those derived from the thermograph trace and 22 GMT for those read in the Stevenson screen.

Fort William School December 1883 to December 1890

The tables contain for the observation hours of 08, 09, 14, 18 and 21 GMT:

Pressure reduced to mean sea level and 0 °C in inches of mercury; and
Dry-bulb and wet-bulb temperatures in degree Fahrenheit in a Stevenson screen.

Also published are:

Maximum and minimum temperatures in degrees Fahrenheit read at 18 GMT for maximum and 09 GMT for minimum;
Direction and force of the wind at 09 and 21 GMT;
Cloud amount in tenths at 09, 14 and 21 GMT; and
Rainfall total for the day in inches, read at 09 GMT.

5. Unpublished data

The archives of Meteorological Office, Edinburgh contain a considerable amount of unpublished data from the Ben Nevis and Fort William observations. In particular the daily observation sheets for the Ben Nevis Observatory, copies of which were sent to the offices of the Scottish Meteorological Society and the Meteorological Office in London, contain additional entries for visibility, type of precipitation, type of cloud, and special phenomena (such as thunderstorms, squalls, etc.). These sheets set out the observations in a form very similar to the hourly returns which have been provided by Meteorological Office and auxiliary synoptic stations in recent years.

The original observation notebooks for the Fort William Observatory are also available and these contain estimates of wind speed and direction for the hours when manual observations were made.

6. Summary tables

Summary tables for the period of operation of the Ben Nevis and Fort William Observatories are contained in volume 43 of the *Transactions of the Royal Society of Edinburgh*. Part of these summaries is given in Table VI.

Table VI. *Summaries of observations at Ben Nevis and Fort William Observatories*

(a) Mean temperature 1884–1903 at Ben Nevis in degrees Fahrenheit

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
24.0	23.8	24.0	27.6	33.0	39.7	41.1	40.4	38.0	31.4	28.9	25.2	31.4

(b) Mean temperature 1891–1903 at Fort William in degrees Fahrenheit

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
38.7	38.8	40.4	45.1	49.7	55.4	57.1	56.5	53.2	46.6	44.0	40.1	47.1

(c) Mean hours of sunshine as % of possible 1884-1903 at Ben Nevis

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
10	16	15	19	23	22	16	13	16	13	11	9	16

(d) Mean time summit clear of fog or mist as % of possible 1884–1903 at Ben Nevis

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
22	27	28	39	45	46	36	30	30	27	22	21	31

(e) Wind direction as % of total observations 1884–1903 at Ben Nevis for complete year

N	NE	E	SE	S	SW	W	NW	CALM
20	8	7	13	13	13	12	8	6

(f) Mean wind speed (Ben Nevis scale) 1884–1903 at Ben Nevis

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
2.89	2.68	2.50	2.26	1.95	1.75	1.64	1.72	2.10	2.46	2.68	2.73	2.28

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Note.
The dates given for the references from the *Journal of the Scottish Meteorological Society* may be in error since the Journals did not specifically include a publication date. Dates used are those found in the bound volumes held at the National Meteorological Library, Bracknell.

Award

We note with pleasure that the International Meteorological Organization Prize for 1983 has been awarded by the Executive Council of the World Meteorological Organization (WMO) jointly to Professor Juan Jacinto Burgos, Professor Emeritus at the University of Buenos Aires, Argentina and to Mr Mohamed Fathi Taha, Counsellor in Meteorology to the Ministry of Civil Aviation, Egypt.

Professor Burgos started his career as an agricultural engineer in 1936, later holding high academic posts in agronomy at the Universities of La Plata and Buenos Aires. He was Head of the Agricultural Meteorology Division of the Argentine National Meteorological Service and has published numerous papers on agrometeorology. He was first President of the WMO Commission for Agricultural Meteorology, a position he held from 1951 to 1958, and was President of the Argentine National Committee for the Global Atmospheric Research Programme in 1976.

Mr Taha started his career as an aeronautical meteorologist in 1934, subsequently becoming Head of the Egyptian Meteorological Department in 1953, and Chairman of the Egyptian Meteorological Authority (which replaced it) from 1971 to 1976. He has served on many national and international committees concerned with the development of meteorology and other geophysical sciences, and served as President of WMO for two consecutive terms from 1971 to 1978.

Notes and news

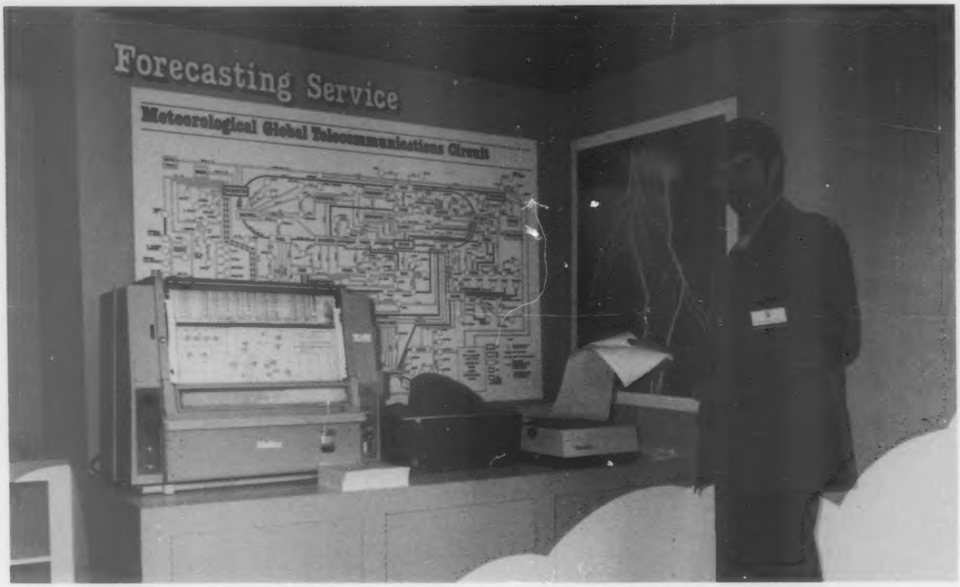
The Steeple Challenge Trophy

The Meteorological Office stand at the Bath and West Show (Shepton Mallet, 1–4 June 1983) was awarded the Steeple Challenge Trophy for the best stand in the show with a frontage of 30 feet or less.

The trophy was presented to Mr Ted Young, the stand manager, by the Lord-Lieutenant of Somerset, Lt.-Col. G. W. F. Luttrell, MC.

Mr Ted Young, on the right, receives the Steeple Challenge Trophy on behalf of the Meteorological Office from the Lord-Lieutenant of Somerset, Lt.-Col. G. W. F. Luttrell, MC.

The Meteorological Office stand at the Bath and West Show, Shepton Mallet, 1–4 June 1983.



Mr R. Downton, Bristol Weather Centre, on duty at the Bath and West Show, Shepton Mallet, 1–4 June 1983.

Some visitors to the Meteorological Office stand at the Bath and West Show, Shepton Mallet, 1–4 June 1983.

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NOTICES

It is requested that all books for review and communications for the Editor be addressed to the Director-General, Meteorological Office, London Road, Bracknell, Berkshire RG12 2SZ and marked 'For Meteorological Magazine'.

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